US009206733B2

(12) **United States Patent**
Balsley, II

(10) **Patent No.: US 9,206,733 B2**
(45) **Date of Patent: Dec. 8, 2015**

(54) **TURBOCHARGER ASSEMBLY WITH DIRECT-MOUNTED BEARING HOUSING**

(71) Applicant: **GM GLOBAL TECHNOLOGY OPERATIONS LLC**, Detroit, MI (US)

(72) Inventor: **Richard Lee Balsley, II**, Ortonville, MI (US)

(73) Assignee: **GM Global Technology Operations LLC**, Detroit, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 228 days.

(21) Appl. No.: **13/929,910**

(22) Filed: **Jun. 28, 2013**

(65) **Prior Publication Data**

US 2015/0000272 A1 Jan. 1, 2015

(51) **Int. Cl.**

F02B 33/44	(2006.01)
F04B 17/00	(2006.01)
F02B 37/12	(2006.01)
F01D 25/16	(2006.01)

(52) **U.S. Cl.**

CPC ***F02B 37/12*** (2013.01); ***F01D 25/16*** (2013.01); *F05B 2220/40* (2013.01)

(58) **Field of Classification Search**

CPC F02B 37/12; F01D 25/16; F05B 2220/40
USPC 60/605.3; 417/407; 184/6.11
See application file for complete search history.

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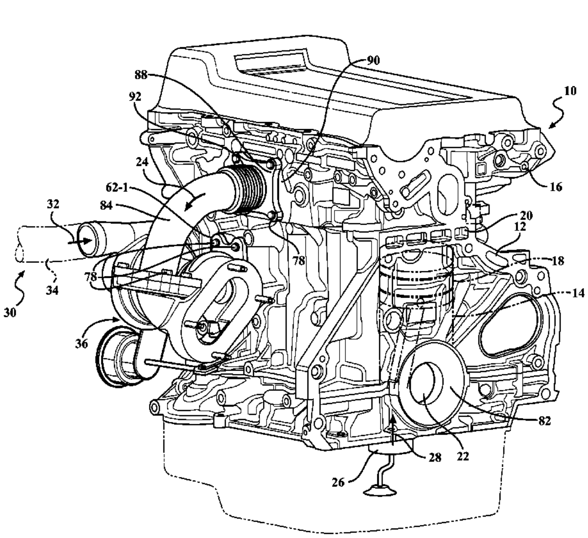
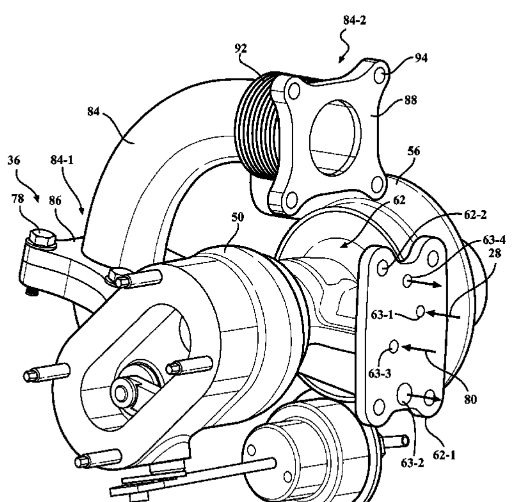
Primary Examiner — Thai Ba Trieu
Assistant Examiner — Vikansha Dwivedi
(74) *Attorney, Agent, or Firm* — Quinn Law Group, PLLC

(57) **ABSTRACT**

A turbocharger pressurizes an airflow for delivery to an internal combustion engine having a cylinder block, a cylinder head, and an oil supply passage formed in at least one of the cylinder block and the cylinder head. The turbocharger includes a bearing housing having a mounting flange for direct mounting to one of the cylinder block and the cylinder head to thereby establish fluid communication with the oil supply passage. The bearing housing also includes a journal bearing, a thrust bearing assembly, and a rotating assembly. The mounting flange defines an oil feed opening configured to correspond to an oil supply passage in one of the cylinder block and the cylinder head and to direct oil to the journal bearing and the thrust bearing assembly when the mounting flange is attached to the engine. An internal combustion engine employing such a turbocharger is also disclosed.

18 Claims, 5 Drawing Sheets





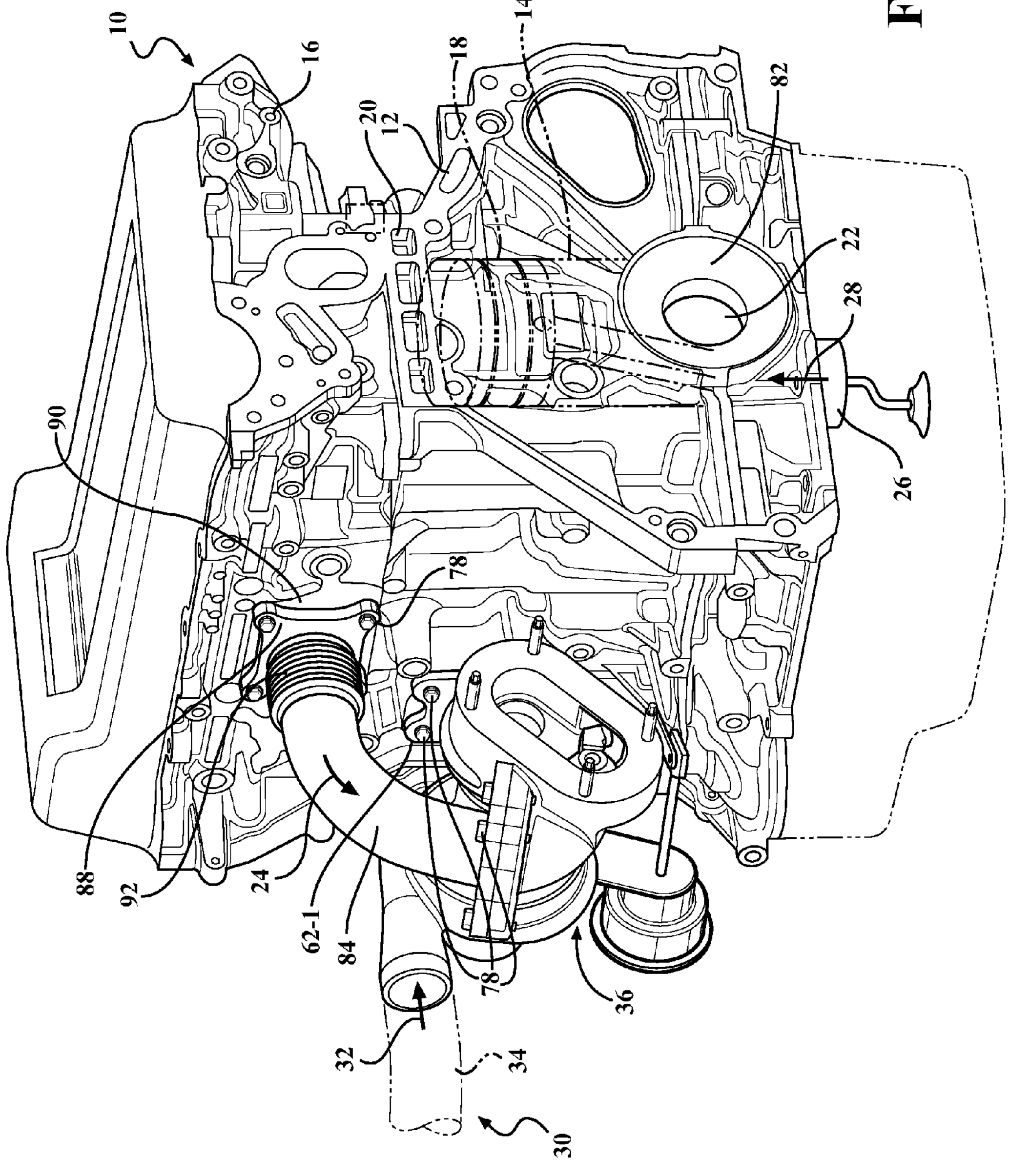


FIG. 1

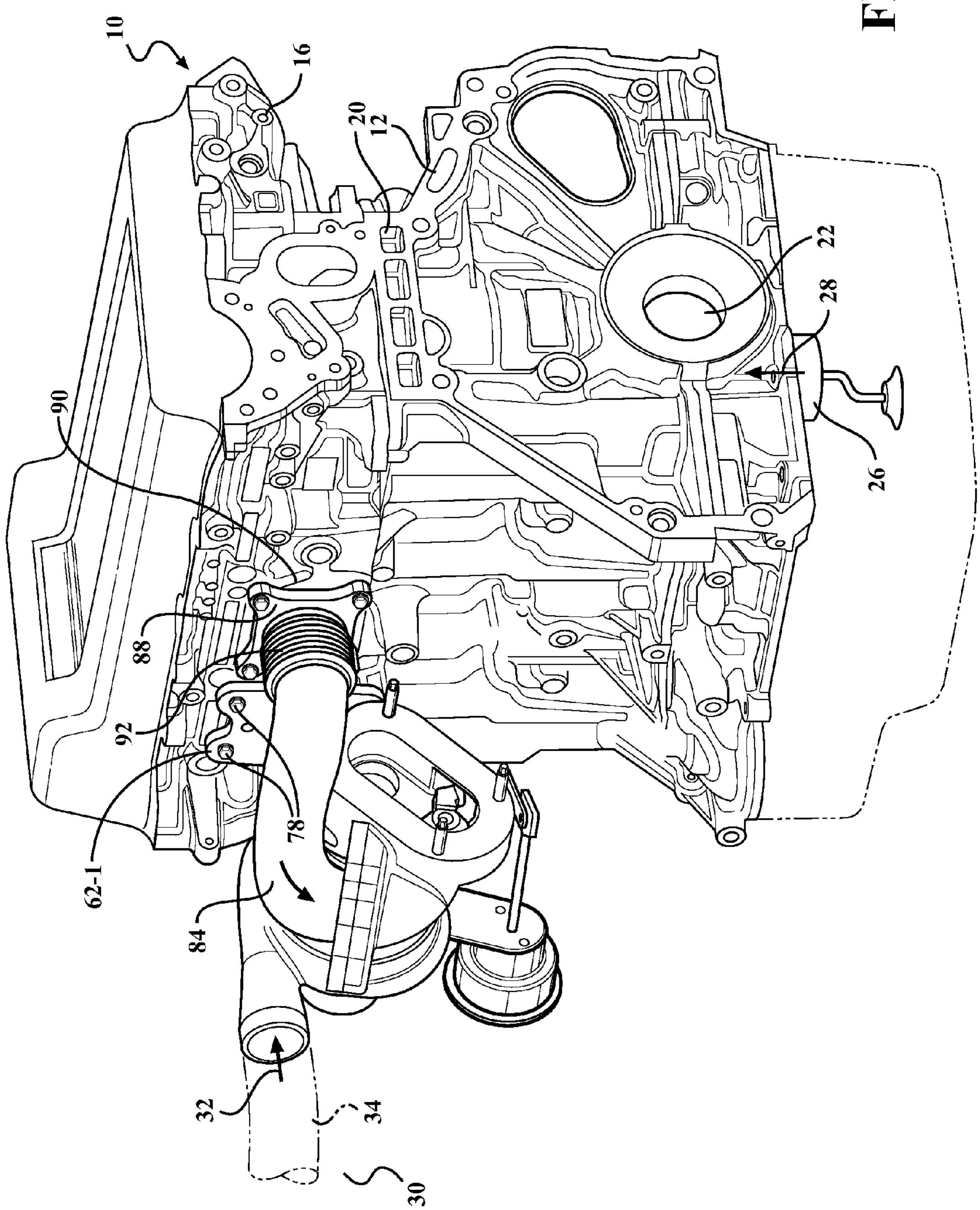


FIG. 2

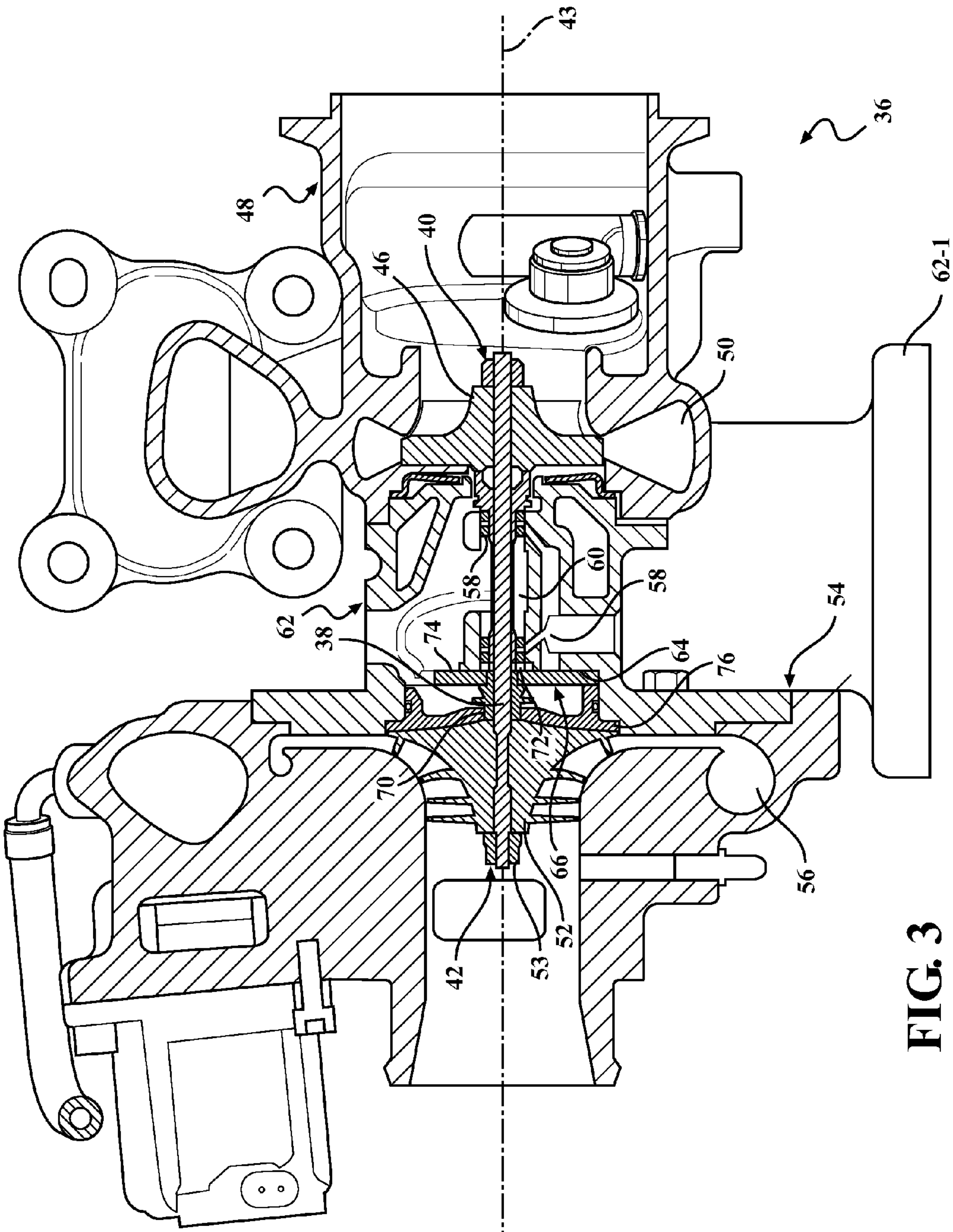


FIG. 3

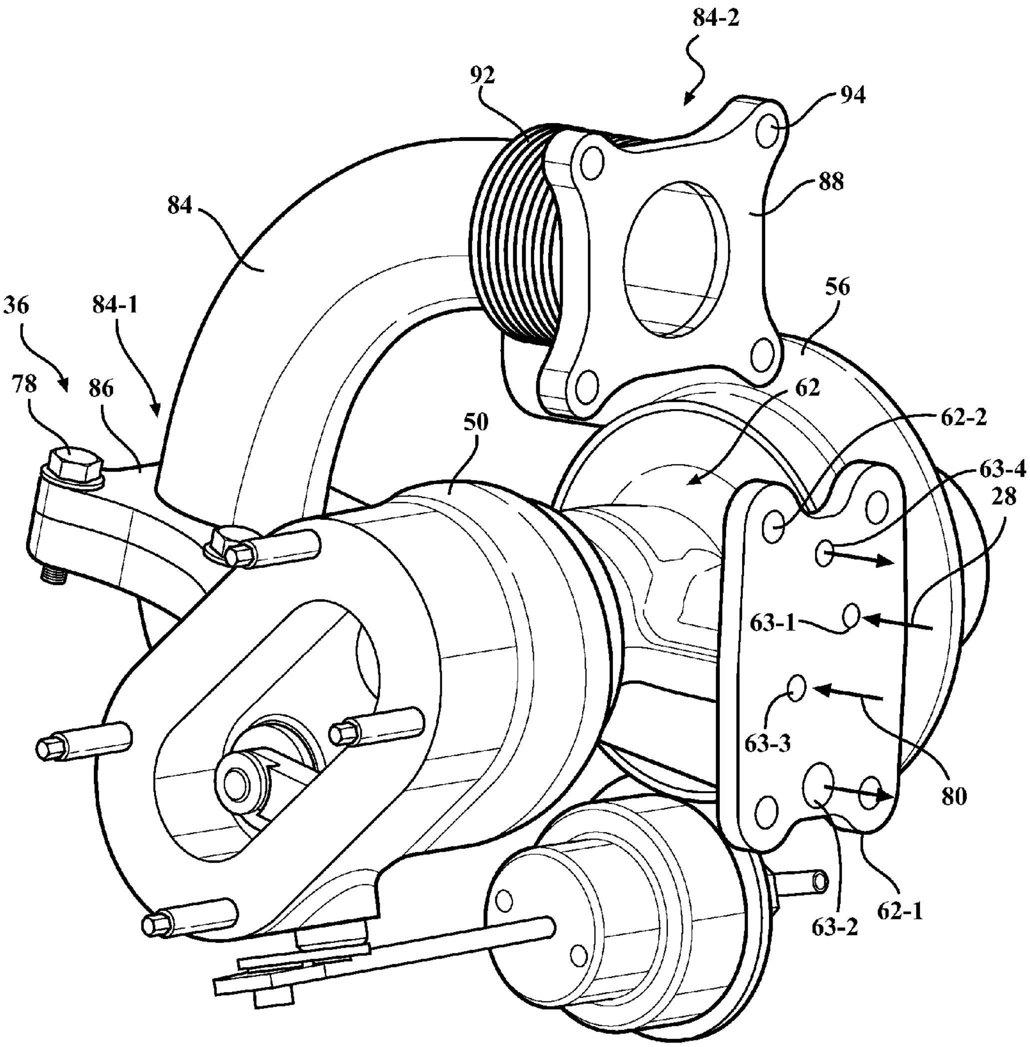


FIG. 4

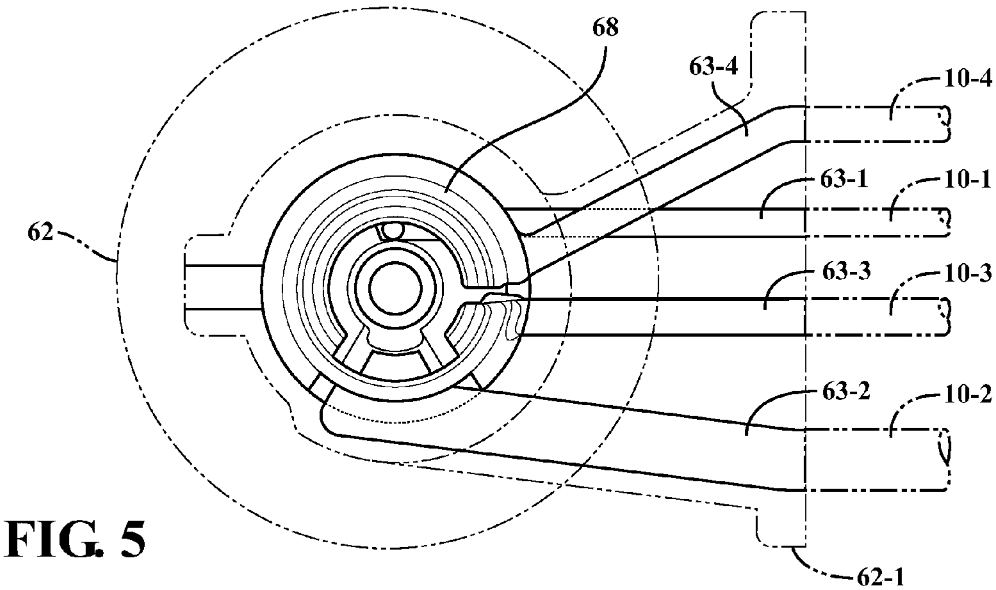

68
63-4
10-4
63-1
10-1
62
63-3
10-3
63-2
10-2
62-1

FIG. 5

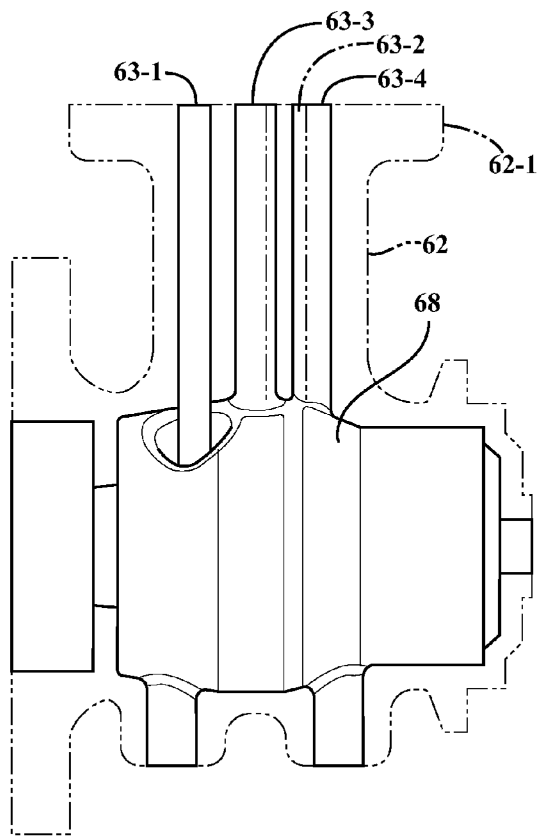

63-3
63-2
63-1
63-4
62-1
62
68

FIG. 6

TURBOCHARGER ASSEMBLY WITH DIRECT-MOUNTED BEARING HOUSING

TECHNICAL FIELD

The present disclosure relates to a turbocharger assembly having a direct-mounted bearing housing.

BACKGROUND

Internal combustion engines (ICE) are often called upon to generate considerable levels of power for prolonged periods of time on a dependable basis. Many such ICE assemblies employ a supercharging device, such as an exhaust gas turbine driven turbocharger, to compress the airflow before it enters the intake manifold of the engine in order to increase power and efficiency.

Specifically, a turbocharger is a centrifugal gas compressor that forces more air and, thus, more oxygen into the combustion chambers of the ICE than is otherwise achievable with ambient atmospheric pressure. The additional mass of oxygen-containing air that is forced into the ICE improves the engine's volumetric efficiency, allowing it to burn more fuel in a given cycle, and thereby produce more power.

A typical turbocharger includes a central shaft that is supported by one or more bearings and that transmits rotational motion between an exhaust-driven turbine wheel and an air compressor wheel. Both the turbine and compressor wheels are fixed to the shaft, which in combination with various bearing components constitute the turbocharger's rotating assembly.

Because the rotating assembly frequently operates at speeds over 100,000 revolutions per minute (RPM) and absorbs significant amount of heat from the engine's exhaust gasses whose temperature may approach 2,000 degrees Fahrenheit, cooling of the turbocharger bearings is essential for long term durability of the turbocharger. To thus cool the turbocharger bearings, water and oil are typically supplied to the rotating assembly.

SUMMARY

One embodiment of the disclosure is directed to a turbocharger assembly for pressurizing an airflow for delivery to an internal combustion engine having a cylinder block and a cylinder head. The turbocharger assembly includes a bearing housing having a mounting flange for direct mounting to one of the cylinder block and the cylinder head. The turbocharger assembly also includes a journal bearing disposed along an axis within a bore of the bearing housing. The turbocharger assembly also includes a rotating assembly supported by the journal bearing and configured to be rotated about the axis by the post-combustion gasses. The turbocharger assembly additionally includes a thrust bearing assembly configured to absorb thrust forces generated by the rotating assembly when the airflow is being pressurized. The mounting flange defines an oil feed opening configured to correspond to an oil supply passage in at least one of the cylinder block and the cylinder head and to direct oil to the journal bearing and the thrust bearing assembly when the mounting flange is attached to one of the cylinder block and the cylinder head.

The turbocharger rotating assembly may include a shaft having a first end and a second end, the shaft being supported by the journal bearing for rotation about the axis. The turbocharger rotating assembly may also include a turbine wheel fixed to the shaft proximate to the first end and configured to be rotated about the axis by the post-combustion gasses. The turbocharger rotating assembly may additionally include a compressor wheel fixed to the shaft proximate to the second end and configured to pressurize the airflow being received from the ambient for delivery to the cylinder.

The turbine wheel may be disposed inside a turbine housing having a turbine scroll, while the compressor wheel may be disposed inside a compressor cover having a compressor scroll. In such a case, each of the compressor scroll and the turbine scroll may be attached to the bearing housing.

The turbocharger assembly may additionally include an exhaust connector pipe configured to direct the post-combustion gasses from the cylinder head to the turbine scroll.

The cylinder head may include an integrated exhaust manifold having a mounting surface. In such a case, the exhaust connector pipe may be configured to attach to the cylinder head at the mounting surface.

The exhaust connector pipe may include a flexible coupling configured to take up vibration and positioning variance between the cylinder head and the turbine scroll.

The flexible coupling may define a plurality of apertures configured to accept fasteners for attachment of the turbocharger assembly to one of the cylinder block and the cylinder head.

The flexible coupling may be configured as one of a corrugated pipe and a mesh sleeve, each of which may be structured from a stainless steel.

The engine may additionally include a coolant supply passage, a coolant pump configured to pressurize coolant, and an oil pump configured to pressurize the oil. The bearing housing may include a coolant or water jacket arranged proximate to each of the journal bearing and the thrust bearing assembly. The mounting flange may additionally define a coolant feed opening configured to match up to the coolant supply passage when the mounting flange is attached to one of the cylinder block and the cylinder head and supply the coolant to the coolant jacket. The pressurized oil may be directed to the bearing housing via the oil supply passage to lubricate the journal bearing and the thrust bearing assembly. The coolant may be directed to the bearing housing via the coolant supply passage to absorb and remove heat from the oil that lubricates the journal bearing and the thrust bearing assembly.

The mounting flange may define a plurality of apertures configured to accept fasteners for attachment of the bearing housing to one of the cylinder block and the cylinder head.

Furthermore, the bearing housing may be formed from an aluminum alloy.

Another embodiment of the present disclosure is directed to an internal combustion engine having the turbocharger as described above.

The above features and advantages, and other features and advantages of the present disclosure, will be readily apparent from the following detailed description of the embodiment(s) and best mode(s) for carrying out the described invention when taken in connection with the accompanying drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an engine with a turbocharger according to an embodiment of the disclosure.

FIG. **2** is a perspective view of an engine with a turbocharger according to another embodiment of the disclosure.

FIG. **3** is a partial cross-sectional view of the turbocharger shown in FIGS. **1-2**.

FIG. **4** is a perspective view of the turbocharger shown in FIG. **1** showing a mounting flange according to the disclosure.

FIG. **5** is a close up side view of a bearing housing for the turbocharger shown in FIGS. **1-4**, with the bearing housing having oil and coolant feed openings in the mounting flange.

FIG. **6** is a close up top view of the bearing housing shown in FIG. **5**.

DETAILED DESCRIPTION

Referring to the drawings wherein like reference numbers correspond to like or similar components throughout the several figures, FIG. **1** illustrates an internal combustion engine **10**. The engine **10** also includes a cylinder block **12** with a plurality of cylinders **14** arranged therein. The engine **10** may define an oil supply passage **10-1**, an oil return passage **10-2**, a coolant supply passage **10-3**, and a coolant return passage **10-4** (shown in FIGS. **5-6**).

As shown in FIG. **1**, the engine **10** also includes a cylinder head **16** that is mounted on the cylinder block **12**. The oil supply passage **10-1**, oil return passage **10-2**, coolant supply passage **10-3**, and coolant return passage **10-4** may be defined by either the cylinder block **12** or the cylinder head **16**. Each cylinder **14** includes a piston **18** configured to reciprocate therein. Combustion chambers **20** are formed within the cylinders **14** between the bottom surface of the cylinder head **16** and the tops of the pistons **18**. As known by those skilled in the art, each of the combustion chambers **20** receives fuel and air from the cylinder head **16** that form a fuel-air mixture for subsequent combustion inside the subject combustion chamber. The cylinder head **16** is also configured to exhaust post-combustion gasses from the combustion chambers **20**.

The engine **10** also includes a crankshaft **22** configured to rotate within the cylinder block **12**. The crankshaft **22** is rotated by the pistons **18** as a result of an appropriately proportioned fuel-air mixture being burned in the combustion chambers **20**. After the air-fuel mixture is burned inside a specific combustion chamber **20**, the reciprocating motion of a particular piston **18** serves to exhaust post-combustion gases **24** from the respective cylinder **14**. The engine **10** also includes an oil pump **26**. The oil pump **26** is configured to supply pressurized engine oil **28** to various bearings, such as that of the crankshaft **22**. The oil pump **26** may be driven directly by the engine **10**, or by an electric motor (not shown).

The engine **10** additionally includes an induction system **30** configured to channel an airflow **32** from the ambient to the cylinders **14**. The induction system **30** includes an intake air duct **34**, a turbocharger **36**, and an intake manifold (not shown). Although not shown, the induction system **30** may additionally include an air filter upstream of the turbocharger **36** for removing foreign particles and other airborne debris from the airflow **32**. The intake air duct **34** is configured to channel the airflow **32** from the ambient to the turbocharger **36**, while the turbocharger is configured to pressurize the received airflow, and discharge the pressurized airflow to the intake manifold. The intake manifold in turn distributes the previously pressurized airflow **32** to the cylinders **14** for mixing with an appropriate amount of fuel and subsequent combustion of the resultant fuel-air mixture. FIG. **1** shows one embodiment of the engine **10** having the turbocharger **36** mounted to the cylinder block **12**, while FIG. **2** shows an alternative embodiment of the engine **10** having the turbocharger **36** mounted to the cylinder head **16**.

As shown in FIG. **3**, the turbocharger **36** may include a rotating assembly **37**. The rotating assembly **37** includes a shaft **38** having a first end **40** and a second end **42**. The rotating assembly **37** also includes a turbine wheel **46** mounted on the shaft **38** proximate to the first end **40** and configured to be rotated along with the shaft **38** about an axis **43** by post-combustion gasses **24** emitted from the cylinders **14**. The turbine wheel **46** is typically formed from a temperature and oxidation resistant material, such as a nickel-chromium-based "inconel" super-alloy to reliably withstand temperatures of the post-combustion gasses **24**, which in some engines may approach 2,000 degrees Fahrenheit. The turbine wheel **46** is disposed inside a turbine housing **48** that includes a turbine volute or scroll **50**. The turbine scroll **50** receives the post-combustion exhaust gases **24** and directs the exhaust gases to the turbine wheel **46**. The turbine scroll **50** is configured to achieve specific performance characteristics, such as efficiency and response, of the turbocharger **36**.

As further shown in FIG. **3**, the rotating assembly **37** also includes a compressor wheel **52** mounted on the shaft **38** between the first and second ends **40**, **42**. The compressor wheel **52** is retained on the shaft **38** via a specially configured fastener, such as a jam nut **53**. As understood by those skilled in the art, a jam nut **53** is a type of a fastener that includes pinched or unequal thread pitch internal threads to engage external threads of a mating component, for example the shaft **38**. Such a thread configuration of the jam nut **53** serves to minimize the likelihood of the jam nut coming loose from the shaft **38** during operation of the turbocharger **36**. Additionally, the direction of the thread on the jam nut **53** may be selected such that the jam nut will have a tendency to tighten rather than loosen as the shaft **38** is spun up by the post-combustion gasses **24**.

The compressor wheel **52** is configured to pressurize the airflow **32** being received from the ambient for eventual delivery to the cylinders **14**. The compressor wheel **52** is disposed inside a compressor cover **54** that includes a compressor volute or scroll **56**. The compressor scroll **56** receives the airflow **32** and directs the airflow to the compressor wheel **52**. The scroll **56** is configured to achieve specific performance characteristics, such as peak airflow and efficiency of the turbocharger **36**. Accordingly, rotation is imparted to the shaft **38** by the post-combustion exhaust gases **24** energizing the turbine wheel **46**, and is in turn communicated to the compressor wheel **52** owing to the compressor wheel being fixed on the shaft. As understood by those skilled in the art, the variable flow and force of the post-combustion exhaust gases **24** influences the amount of boost pressure that may be generated by the compressor wheel **52** throughout the operating range of the engine **10**. The compressor wheel **52** is typically formed from a high-strength aluminum alloy that provides the compressor wheel with reduced rotating inertia and quicker spin-up response.

With continued reference to FIG. **3**, the rotating assembly **37** is supported for rotation about the axis **43** via journal bearings **58**. The journal bearings **58** are mounted in a bore **60** along the axis **43** within a bearing housing **62** and is lubricated and cooled by the supply of pressurized engine oil **28** supplied via the pump **26**. The bearing housing **62** may be formed from a suitable robust material, such as an aluminum-silicon alloy or a nodular cast iron, that can withstand appropriate thermal and mechanical stresses, and maintain dimensional stability of the bore **60** for operational support of the rotating assembly **37**. The journal bearings **58** are configured to control radial motion and vibrations of the shaft **38**. As shown, the journal bearings **58** may be fully-floating or a semi-floating type that are formed from a relatively soft metal, for example brass or bronze, such that any debris that passes through the bearing system would become embedded in the soft bearing material and not damage the shaft **38** or the bore **60**. The journal bearings **58** may also be configured as roller or ball bearings to further reduce turbocharger frictional losses during rotation of the shaft **38**.

As shown in FIG. **3**, the bearing housing **62** includes a thrust wall **64**. Additionally, the turbocharger **36** includes a thrust bearing assembly **66**. The thrust bearing assembly **66** is configured to absorb thrust forces generated by the rotating assembly **37** while the turbocharger **36** is pressurizing the airflow **32**. The thrust bearing assembly **66** includes a thrust collar **70** and a thrust washer **72**. The thrust bearing assembly **66** also includes a thrust plate **74** that is held in place by a thrust retainer **76** against the thrust wall **64**. The bearing surface of the thrust plate **74** is typically formed from a relatively soft metal, for example brass or bronze, such that any debris that passes through the bearing system would become embedded in the soft bearing material and not damage the thrust collar **70** or the thrust washer **72**. The thrust retainer **76** may be held in place by a clip, one or more bolts, or otherwise attached to the housing **62** in order to hold the thrust bearing assembly **66** securely against the thrust wall **64**.

During operation of the turbocharger **36**, the pressurized engine oil **28** from the pump **26** is delivered to the bearing housing **62**. Inside the bearing housing **62**, the pressurized engine oil **28** is directed via dedicated cast passages to lubricate the thrust bearing assembly **66** and generate an oil film between the thrust washer **72** and the thrust plate **74**. Such an oil film serves to reduce the likelihood of direct physical contact between the thrust washer **72** and the thrust plate **74**. In turn, such reduction of direct contact between the thrust washer **72** and the thrust plate **74** serves to extend useful life of the thrust bearing assembly **66** and, accordingly, the durability of the turbocharger **36**.

As shown in each of the FIGS. **3** and **4**, the bearing housing **62** includes a mounting flange **62-1** configured for direct mounting to either the cylinder block **12** (shown in FIG. **1**) or to the cylinder head **16** (shown in FIG. **2**). As shown in FIG. **4**, the mounting flange **62-1** may define a plurality of apertures **62-2**, each configured to accept a fastener **78** for reliable attachment of the bearing housing **62** to the cylinder block **12** or to the cylinder head **16**. The mounting flange **62-1** defines an oil feed opening **63-1** configured to match up or correspond to the oil supply passage **10-1** and direct the oil to the journal bearing **58** and the thrust bearing assembly **66** when the mounting flange is attached to either the cylinder block **12** or the cylinder head **16**. The mounting flange **62-1** also defines an oil return opening **63-2** configured to match up to the oil return passage **10-2** and remove the oil from the bearing housing **62** after the oil has been circulated therethrough and lubricated the journal bearing **58** and the thrust bearing assembly **66**. The pressurized oil **28** is directed to the bearing housing **62** via the oil supply passage **10-1** to lubricate the journal bearings **58** and the thrust bearing assembly **66**. Following the oil exiting the bearing housing **62** via the oil return opening **63-2**, the oil goes back to the engine **10** via the oil return passage **10-2** to the oil pump **26**.

The mounting flange **62-1** also defines a coolant feed opening **63-3** configured to match up to the coolant supply passage **10-3** when the mounting flange is attached to either the cylinder block **12** (shown in FIG. **1**) or the cylinder head **16** (shown in FIG. **2**). As shown in FIG. **4**, the coolant feed opening **63-3** directs a coolant **80** to a water jacket **68** (shown in FIGS. **5-6**) that is formed inside the bearing housing **62** proximate to the journal bearings **58** and the thrust bearing assembly **66**. The coolant **80** absorbs and removes heat from the oil that had lubricated the journal bearings **58** and the thrust bearing assembly **66**. The mounting flange **62-1** additionally defines a coolant return opening **63-4** configured to match up to the coolant return passage **10-4** and remove the coolant **80** from the water jacket **68** after the coolant has been circulated therethrough. Following the coolant **80** exiting the bearing housing **62** via the coolant return opening **63-4**, the coolant goes back to the engine **10** via the coolant return passage **10-4** to a coolant pump **82** (shown in FIG. **1**). The coolant pump **82** is mounted on the engine **10** and may be either actuated electrically or driven mechanically by the engine itself to pressurize the coolant **80**.

As shown in FIGS. **1**, **2** and **4**, the turbocharger assembly **36** additionally includes an exhaust connector pipe **84** configured to direct the post-combustion gasses **24** from the cylinder head **16** to the turbine scroll **50**. The exhaust connector pipe **84** includes a first end **84-1** and a second end **84-2**. A first connector flange **86** is positioned at the first end **84-1** and is attached to the turbine scroll **50** via a fastener, such as the fastener **78** shown in FIGS. **1**, **2** and **4**. A second connector flange **88** is positioned at the second end **84-2** and is configured for attachment at the cylinder head **16** to an exhaust manifold outlet **90** (shown in FIGS. **1-2**) via fasteners **78**. As to be understood from the fact that the engine **10** includes multiple cylinders **14**, but only a single outlet **90**, the exhaust manifold may be internally cast, i.e., integrated, into the cylinder head **16**. Although the integrated exhaust manifold itself is not shown, the existence and configuration of such a manifold would be understood by those skilled in the art.

The exhaust connector pipe **84** includes a flexible coupling **92** positioned on the second end **84-2** and with the second connector flange **88** secured thereto. The flexible coupling **92** is configured to take up positioning variance between the cylinder head **16** and the turbine scroll **50**, and the vibration generated by the engine **10** during its operation. The second connector flange **88** secured to the flexible coupling **92** defines a plurality of apertures **94**, with each aperture configured to accept a fastener, such as the fastener **78** shown in FIGS. **1-2**, for attachment of the turbocharger assembly **36** to the cylinder head **16**. The flexible coupling **92** may be configured, i.e., designed and fabricated, as a corrugated pipe (shown in FIGS. **1**, **2**, and **3**) or a mesh sleeve (not shown) from a suitable heat resistant material, such as stainless steel.

The detailed description and the drawings or figures are supportive and descriptive of the invention, but the scope of the invention is defined solely by the claims. While some of the best modes and other embodiments for carrying out the claimed invention have been described in detail, various alternative designs and embodiments exist for practicing the invention defined in the appended claims. Furthermore, the embodiments shown in the drawings or the characteristics of various embodiments mentioned in the present description are not necessarily to be understood as embodiments independent of each other. Rather, it is possible that each of the characteristics described in one of the examples of an embodiment can be combined with one or a plurality of other desired characteristics from other embodiments, resulting in other embodiments not described in words or by reference to the drawings. Accordingly, such other embodiments fall within the framework of the scope of the appended claims.

The invention claimed is:

1. An internal combustion engine comprising:

a cylinder block defining a cylinder;

a reciprocating piston disposed inside the cylinder;

a cylinder head mounted to the cylinder block and configured to supply an air-fuel mixture to the cylinder for combustion therein and exhaust post-combustion gasses therefrom;

an oil supply passage formed in at least one of the cylinder block and the cylinder head; and

a turbocharger assembly configured to pressurize an airflow being received from the ambient for delivery to the cylinder, the turbocharger assembly including:

a bearing housing having a mounting flange configured to be mounted directly to the cylinder head to thereby establish fluid communication with the oil supply passage;

a journal bearing disposed along an axis within the bearing housing;

a rotating assembly supported by the journal bearing and configured to be rotated about the axis by the post-combustion gasses; and

a thrust bearing assembly configured to absorb thrust forces generated by the rotating assembly when the airflow is being pressurized;

an exhaust connector pipe configured to direct the post-combustion gasses from the cylinder head to the rotating assembly and having a flexible coupling configured to take up vibration and positioning variance between the cylinder head and the turbocharger assembly;

wherein the mounting flange defines an oil feed opening configured to correspond to the oil supply passage and direct oil to the journal bearing and the thrust bearing assembly when the mounting flange is attached to the cylinder head.

2. The engine of claim **1**, wherein the rotating assembly includes:

a shaft having a first end and a second end, the shaft being supported by the journal bearing for rotation about the axis;

a turbine wheel fixed to the shaft proximate to the first end and configured to be rotated about the axis by the post-combustion gasses; and

a compressor wheel fixed to the shaft proximate to the second end and configured to pressurize the airflow being received from the ambient for delivery to the cylinder;

wherein:

the turbine wheel is disposed inside a turbine housing having a turbine scroll;

the compressor wheel is disposed inside a compressor cover having a compressor scroll; and

the compressor scroll and the turbine scroll are each attached to the bearing housing.

3. The engine of claim **2**, wherein the exhaust connector pipe is configured to direct the post-combustion gasses from the cylinder head to the turbine scroll.

4. The engine of claim **3**, wherein the cylinder head includes an integrated exhaust manifold having a mounting surface, and wherein the exhaust connector pipe is configured to attach to the cylinder head at the mounting surface.

5. The engine of claim **1**, wherein the exhaust connector pipe includes a connector flange secured at the flexible coupling and defining a plurality of apertures configured to accept fasteners for attachment of the turbocharger assembly to the cylinder head.

6. The engine of claim **1**, wherein the flexible coupling is configured as one of a corrugated pipe and a mesh sleeve.

7. The engine of claim **1**, further comprising a coolant supply passage, a coolant pump configured to pressurize coolant, and an oil pump configured to pressurize the oil;

wherein:

the bearing housing includes a coolant jacket arranged proximate to each of the journal bearing and the thrust bearing assembly;

the mounting flange additionally defines a coolant feed opening configured to match up to the coolant supply passage when the mounting flange is attached to one of the cylinder block and the cylinder head and supply the coolant to the coolant jacket;

the pressurized oil is directed to the bearing housing via the oil supply passage to lubricate the journal bearing and the thrust bearing assembly; and

the coolant is directed to the bearing housing via the coolant supply passage to absorb and remove heat from the oil that lubricates the journal bearing and the thrust bearing assembly.

8. The engine of claim **1**, wherein the mounting flange defines a plurality of apertures configured to accept fasteners for attachment of the bearing housing to one of the cylinder block and the cylinder head.

9. The engine of claim **1**, wherein the bearing housing is formed from an aluminum alloy.

10. A turbocharger assembly for pressurizing an airflow that is received from the ambient for delivery to an internal combustion engine having a cylinder head mounted to a cylinder block that defines a cylinder, a reciprocating piston disposed inside the cylinder, and an oil supply passage formed in at least one of the cylinder block and the cylinder head, wherein the cylinder head is configured to supply an air-fuel mixture to the cylinder for combustion therein and exhaust post-combustion gasses therefrom, the turbocharger assembly comprising:

a bearing housing having a mounting flange configured to be mounted directly to the cylinder head;

a journal bearing disposed along an axis within the bearing housing;

a rotating assembly supported by the journal bearing and configured to be rotated about the axis by the post-combustion gasses; and

a thrust bearing assembly configured to absorb thrust forces generated by the rotating assembly when the airflow is being pressurized;

an exhaust connector pipe configured to direct the post-combustion gasses from the cylinder head to the rotating assembly and having a flexible coupling configured to take up vibration and positioning variance between the cylinder head and the turbocharger assembly;

wherein the mounting flange defines an oil feed opening configured to correspond to the oil supply passage and direct oil to the journal bearing and the thrust bearing assembly when the mounting flange is attached to the cylinder head.

11. The turbocharger assembly of claim **10**, wherein the rotating assembly includes:

a shaft having a first end and a second end, the shaft being supported by the journal bearing for rotation about the axis;

a turbine wheel fixed to the shaft proximate to the first end and configured to be rotated about the axis by the post-combustion gasses; and

a compressor wheel fixed to the shaft proximate to the second end and configured to pressurize the airflow being received from the ambient for delivery to the cylinder;

wherein:

the turbine wheel is disposed inside a turbine housing having a turbine scroll;

the compressor wheel is disposed inside a compressor cover having a compressor scroll; and

the compressor scroll and the turbine scroll are each attached to the bearing housing.

12. The turbocharger assembly of claim **11**, wherein the exhaust connector pipe is configured to direct the post-combustion gasses from the cylinder head to the turbine scroll.

13. The turbocharger assembly of claim **12**, wherein the cylinder head includes an integrated exhaust manifold having a mounting surface, and wherein the exhaust connector pipe is configured to attach to the cylinder head at the mounting surface.

14. The turbocharger assembly of claim **10**, wherein the exhaust connector pipe includes a connector flange secured at the flexible coupling and defining a plurality of apertures configured to accept fasteners for attachment of the turbocharger assembly to the cylinder head.

15. The turbocharger assembly of claim **10**, wherein the flexible coupling is configured as one of a corrugated pipe and a mesh sleeve.

16. The turbocharger assembly of claim **10**, wherein:

the engine additionally includes a coolant supply passage, a coolant pump configured to pressurize coolant, and an oil pump configured to pressurize the oil;

the bearing housing includes a coolant jacket arranged proximate to each of the journal bearing and the thrust bearing assembly;

the mounting flange additionally defines a coolant feed opening configured to match up to the coolant supply passage when the mounting flange is attached to one of the cylinder block and the cylinder head and supply the coolant to the coolant jacket;

the pressurized oil is directed to the bearing housing via the oil supply passage to lubricate the journal bearing and the thrust bearing assembly; and

the coolant is directed to the bearing housing via the coolant supply passage to absorb and remove heat from the oil that lubricates the journal bearing and the thrust bearing assembly.

17. The turbocharger assembly of claim **10**, wherein the mounting flange defines a plurality of apertures configured to accept fasteners for attachment of the bearing housing to one of the cylinder block and the cylinder head.

18. The turbocharger assembly of claim **10**, wherein the bearing housing is formed from an aluminum alloy.

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